

### ABSTRACT OF THE DISCLOSURE

One or more highly-oriented, multi-walled carbon nanotubes are grown on an outer surface of a substrate initially disposed with a catalyst film or catalyst nano-dot  
5 by plasma enhanced hot filament chemical vapor deposition of a carbon source gas and a catalyst gas at temperatures between 300°C and 3000°C. The carbon nanotubes range from 4 to 500 nm in diameter and 0.1 to 50  $\mu\text{m}$  in length depending on growth conditions. Carbon nanotube density can exceed  $10^4$  nanotubes/ $\text{mm}^2$ . Acetylene is used as the carbon source gas, and ammonia is used as the catalyst gas. Plasma intensity, carbon source gas  
10 to catalyst gas ratio and their flow rates, catalyst film thickness, and temperature of chemical vapor deposition affect the lengths, diameters, density, and uniformity of the carbon nanotubes. The carbon nanotubes of the present invention are useful in electrochemical applications as well as in electron emission, structural composite, material storage, and microelectrode applications.